Attachment H1
Species Descriptions

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Abbreviations and Acronyms

°F	degrees Fahrenheit
CDFG	California Department of Fish and Game
Delta	Sacramento-San Joaquin River Delta
DPS	distinct population segment
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FR	Federal Register
FTWG	Fisheries Technical Working Group
NMFS	National Marine Fisheries Service
POD	pelagic organism decline
SJR	San Joaquin River
USFWS	U.S. Fish and Wildlife Service

Attachment H1
Species Descriptions

H1.1 Species Associated with Pelagic Organism Decline

H1.1.1 Delta Smelt – Threatened

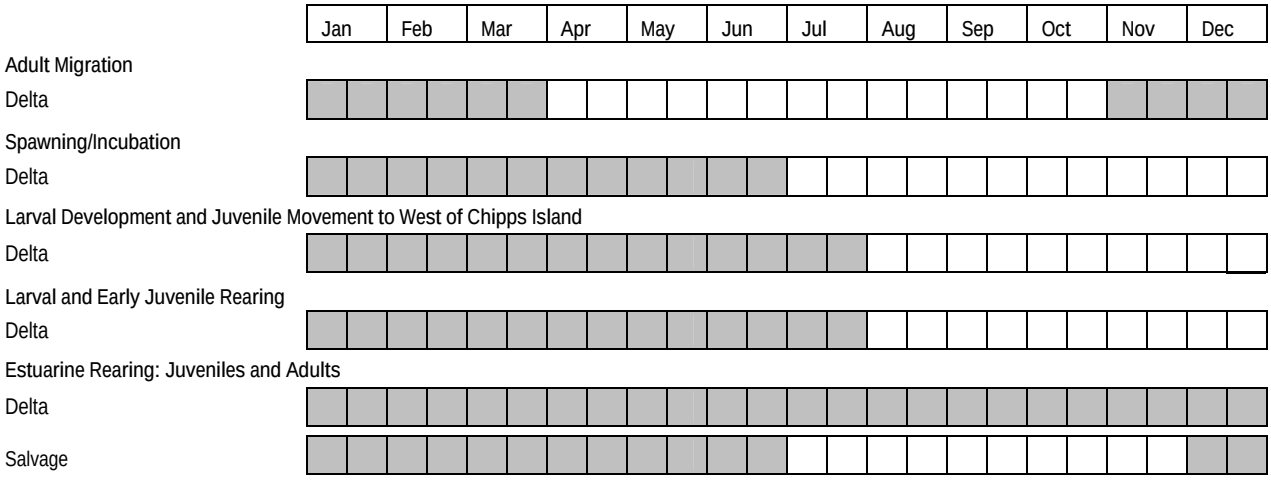
The Delta smelt was listed as threatened by U.S. Fish and Wildlife Service (USFWS) effective April 5, 1993 (USFWS 1993, 58 Federal Register [FR] 12854-12864), and by California Department of Fish and Game (CDFG) on December 9, 1993. The California Fish and Game Commission voted to uplist the species to endangered status under the California Endangered Species Act on March 4, 2009 ("State gives delta smelt species new protections" 2009). The *Sacramento-San Joaquin Delta Native Fishes Recovery Plan* was completed in 1996 (USFWS 1996). A consortium of conservation groups has petitioned the USFWS and the California Fish and Game Commission to change its status to endangered under the Federal and California ESAs (Center for Biological Diversity et al. 2006; Bay Institute et al. 2007a). These petitions are under consideration.

Critical habitat for Delta smelt is defined by the USFWS (1994, 59 FR 65256-65279) as:

> Areas and all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma Sloughs; and the existing contiguous waters contained within the Delta.

Delta smelt are a euryhaline fish (capable of tolerating a wide range of salinities). They are endemic to (found only in) the upper San Francisco Estuary, principally the Sacramento-San Joaquin River Delta (Delta) and Suisun Bay. They occur in the Delta primarily below Isleton on the Sacramento River side and below Mossdale on the San Joaquin River (SJR) side. They are found seasonally throughout Suisun Bay and in small numbers in larger sloughs of Suisun Marsh. They move into sloughs and channels of the western Delta (e.g., Lindsey Slough) when spawning. During high-outflow periods they may be washed into San Pablo Bay, but they do not establish permanent populations there (EA Engineering, Science, and Technology 1999).

During winter and spring (November through March), Delta smelt migrate upstream from the brackish-water estuarine areas to spawn (**Figure H1-1**).[1] They spawn from January through June in shallow, fresh, or slightly brackish tidally influenced backwater sloughs and channel edgewaters with temperatures of 45° to 59 degrees Fahrenheit (°F) (DWR and Reclamation 2005). Eggs are demersal and adhesive. Larvae hatch from 10 to 14 days (Wang 1986) and are planktonic (float with water currents) as they are transported and dispersed downstream into the low-salinity areas within the western Delta and Suisun Bay (Moyle 2002).



Source: Taylor and Wise 2008

Figure H1-1. Timing of Life History Stages for Delta Smelt

The lifespan of Delta smelt typically does not last more than 1 year, although a few individuals live to spawn in their second years. Most adult smelt die after spawning in the early spring. Delta smelt inhabit open surface waters and shoal areas within the western Delta and Suisun Bay for the majority of their 1-year life span (USFWS 1994, 59 FR 65256-65279). Their abundance fluctuates substantially within and among years due to the short life span. Delta smelt abundance is reduced during unusually dry years with exceptionally low outflows (e.g., 1987 through 1991) and unusually wet years with exceptionally high outflows (e.g., 1982 and 1986).

[1] **Figure H1-1** and the similar figures that follow show the times of year when the life stage indicated on the left would be expected to be present in the ecoregion indicated. These periodicities were developed in collaboration with the Fisheries Technical Working Group (FTWG) based on information from a variety of sources, including unpublished data provided by FTWG members.

Other factors thought to affect the abundance and distribution in the Bay-Delta include entrainment, effects of nonnative species on the zooplankton community, and pollution. Results of recent CDFG summer tow-net surveys, 20-millimeter larval surveys, and fall mid-water trawl surveys indicate that Delta smelt abundance and geographic distribution have not shown any significant signs of recovery to pre-1982 levels (USFWS 2004), and have been at or near all-time lows since 2002 (Sommer 2007).

The availability of rearing habitat for Delta smelt is closely tied to the locations of the low salinity zone and X2. In general, adult abundance tends to be highest when X2 is located in Suisun Bay in the spring (Bennett 2005). However, this trend is complicated by a switch in the relationship of X2 to habitat quality after the decline of the Delta smelt began in the early 1980s. Kimmerer (2002) reported that, prior to 1982, smelt abundance was higher when X2 was further east. After 1982, this pattern was reversed. This trend reversal is thought to be due to the decline in habitat quality in the central Delta over time (Bennett 2005).

H1.1.2 Longfin Smelt – Proposed for Listing

Longfin smelt is not currently listed under the Federal ESA. The California Fish and Game Commission approved listing of this species as threatened under the California ESA at their meeting on March 4, 2009 ("State gives delta smelt species new protections" 2009). This species is one of the species associated with the pelagic organism decline (POD) and were previously petitioned for listing in 1993, which the USFWS denied. Environmental groups have petitioned the USFWS and CDFG to list the species as endangered in a petition filed in August 2007, citing their population decline over the last 20 years (Bay Institute et al. 2007b, c).

Longfin smelt is a euryhaline species that lives primarily in the San Francisco Bay and the Delta, but can sometimes be found in the ocean off the Golden Gate. They are most abundant in San Pablo and Suisun bays (Moyle 2002). They spend the early summer in San Pablo and San Francisco bays, generally moving into Suisun Bay in August. Longfin smelt appear to spawn in the Delta, downstream of Rio Vista (Moyle et al. 1995). Most spawning is from January through May (**Figure H1-2**) in water temperatures from 44.6 to 58.1°F (Moyle 2002). Longfin smelt eggs are adhesive and are probably deposited on rocks or aquatic plants during spawning. Newly hatched longfin smelt are swept downstream into more brackish parts of the estuary. The majority of adults die after spawning. Longfin smelt survival is thought to correspond with strong Delta outflow required to transport longfin smelt young to more suitable rearing habitat in Suisun and San Pablo bays (Moyle 2002).

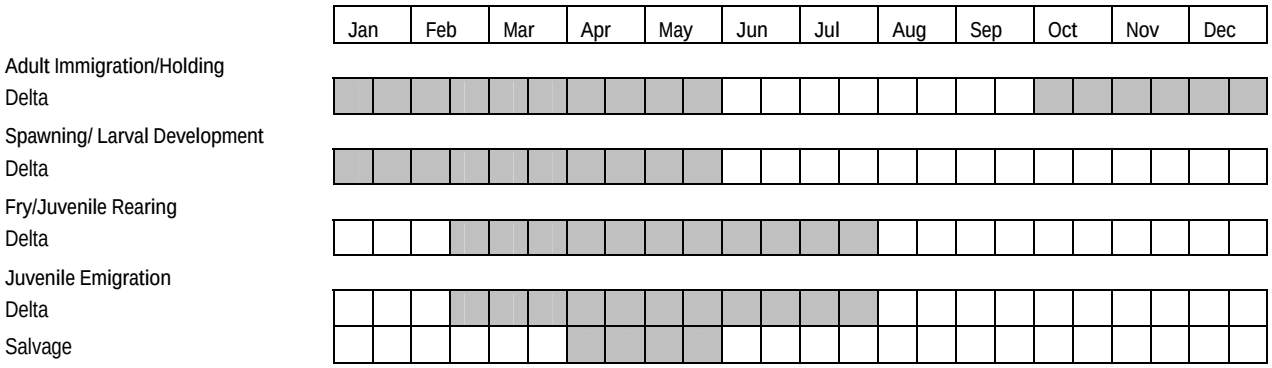


Figure H1-2. Timing of Life History Stages for Longfin Smelt

H1.1.3 Striped Bass – No Legal Status

Striped bass is an introduced species supporting recreational fisheries in the Delta and Central Valley rivers. They are not listed under either Federal or California ESAs, but young-of-year striped bass are associated with the POD.

Striped bass are widespread along the Pacific coast. Adult striped bass spend summer in the Bay, Delta, and major rivers, and may move into the ocean outside the Golden Gate in some years. In the fall, they begin moving inland to the Delta and the rivers. However, they may be found in all of these areas throughout the year. Detailed discussions of the life history and habitat requirements of striped bass in the Delta are reported by CDFG (Fry 1973; Turner and Kelly 1966).

Striped bass begin spawning in the spring when water temperatures reach 59°F. Most spawning occurs from April to June (**Figure H1-3**) when temperatures are from 59 to 65°F (Wang 1986). Spawning occurs in areas of moderate to swift currents. Eggs and larvae that are suspended by the current during their development are more likely to survive than those that settle to the bottom (DWR and Reclamation 2005). Important spawning areas occur in the Delta on the SJR from the Antioch Bridge to Middle River (Fry 1973), especially during years of low flow (Moyle 2002). Successful spawning occurs in the SJR, upstream from the Delta, during years of high flow, when the large volume of runoff dilutes irrigation return water. Embryos and larvae from the Sacramento River are carried into the Delta and Suisun Bay. In the SJR outflow is balanced by tidal current, so that embryos and larvae stay suspended in the same general area in which spawning took place.

Striped bass abundance appears closely related to juvenile survival, especially during the first few months of life. During this period, striped bass are very vulnerable to entrainment and flow conditions as a result of their planktonic

nature. Flow affects suitability of currents necessary to transport embryos and larvae to nursery areas in the Delta (Fry 1973; Moyle 2002).

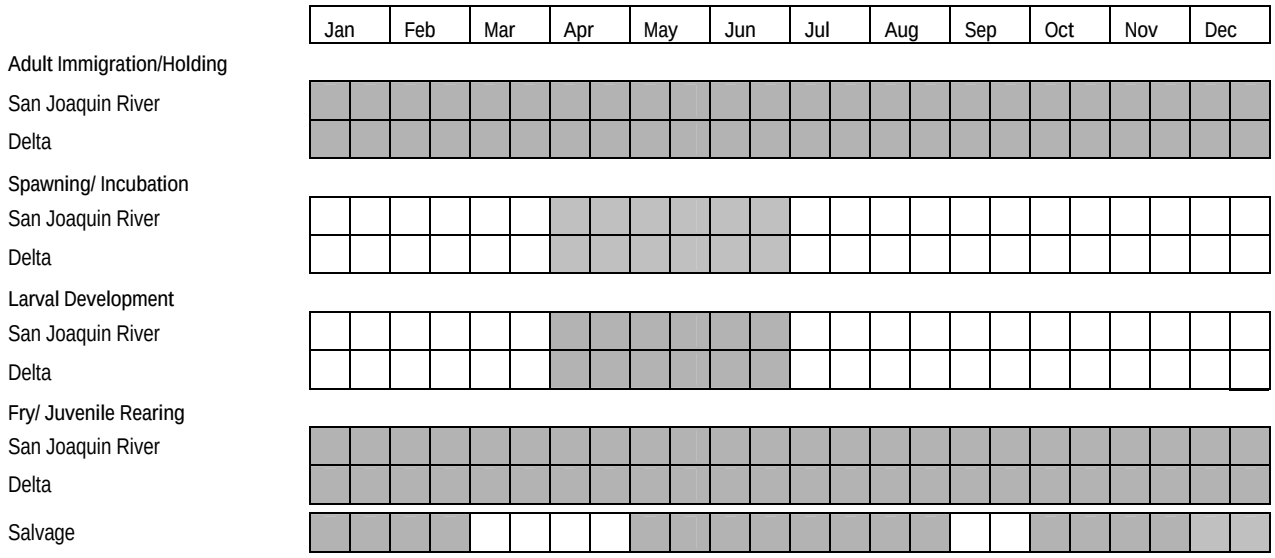


Figure H1-3. Timing of Life History Stages for Striped Bass

H1.1.4 Threadfin Shad – No Legal Status

Threadfin shad were introduced to California as forage fish to improve growth rate of game fishes. Like striped bass, they are not listed, but are one of the species associated with the POD.

Threadfin shad are found in open waters of reservoir, lakes, and large ponds as well as sluggish backwaters of rivers. They prefer warmer waters and do not tolerate sudden drop in temperature or prolonged periods of cold water. The Delta population experiences heavy die-offs every winter when the water temperature cools to 43 to 46°F (Moyle 2002).

Spawning can occur from April through August (**Figure H1-4**), peaking in June and July when water temperature exceeds 68°F. The embryos hatch in 3-6 days and larvae immediately assume a planktonic existence. The duration of this planktonic life stage is suspected to be 2 or 3 weeks depending on temperature (Moyle 2002). The larvae metamorphose into juveniles at about 2 centimeters total length. Juveniles form dense schools and in estuaries are found in water of all salinities, although they are most abundant in freshwater.

In the Delta, threadfin shad are a major item in the diet of striped bass and other piscivorous fishes. Their numbers in the Delta have gradually declined since the late 1970s, reflecting a general decline of planktonic fishes in the estuary (Moyle 2002; Sommer 2007).

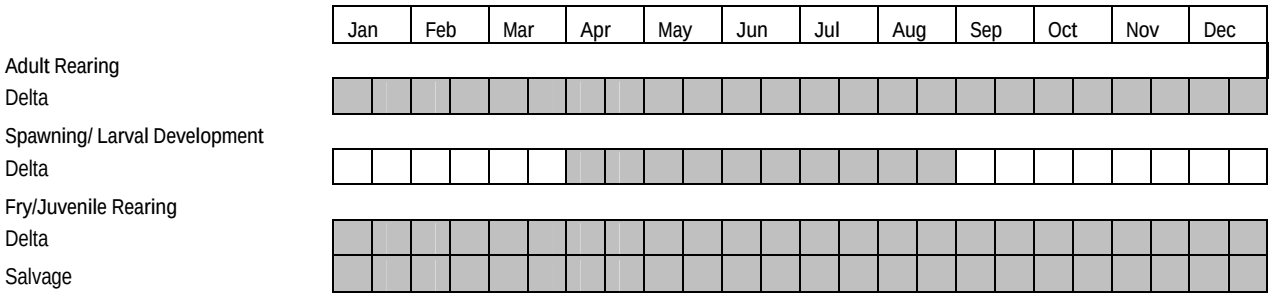


Figure H1-4. Timing of Life History Stages for Threadfin Shad

H1.1.5 Salmonids

Chinook Salmon

Chinook salmon are anadromous fish, which spawn in freshwater and grow to adulthood in the ocean. Four runs of Chinook salmon pass through the Delta.[2] The runs are recognized and named for the timing of their entry into the freshwater environment: (1) fall-run, (2) late-fall-run, (3) winter-run, and (4) spring-run (Hallock and Fry 1967; Healey 1991). The life history and habitat requirements of Chinook salmon have been well documented (e.g., Myers et al. 1998; Healey 1991; Moyle 2002; Reiser and Bjorn 1979). In the descriptions that follow, the freshwater period of their lives is divided into four general life stages: adult upstream migration (immigration), spawning (including incubation and emergence), freshwater rearing, and downstream migration of juveniles/smolts (emigration). The timing of these life history events, egg development upon adult entry to freshwater, and the duration of freshwater rearing differ among the four runs.

Chinook salmon of some race and lifestages are generally present within areas of analysis throughout the year, although water temperatures may be quite stressful during the warmer months. The relative number and distribution of the various life stages change throughout the year depending on the temporal and spatial distribution of the runs. Each of the four runs of Chinook salmon rear in the Delta for variable periods of time, although some fish may simply migrate through the Delta and so may be present for only a short time. The SJR (defined herein as upstream of the head of Old River) and its tributaries support fall run Chinook salmon. The SJR is used primarily as a migration corridor during immigration and emigration, although some limited rearing may occur during emigration. All spawning occurs on the tributaries to the SJR (Merced, Tuolumne, and Stanislaus rivers), as does most rearing.

[2] Note that National Marine Fisheries Service (NMFS) did not find fall- and late-fall-run Chinook salmon to be distinct evolutionarily significant units (ESUs).

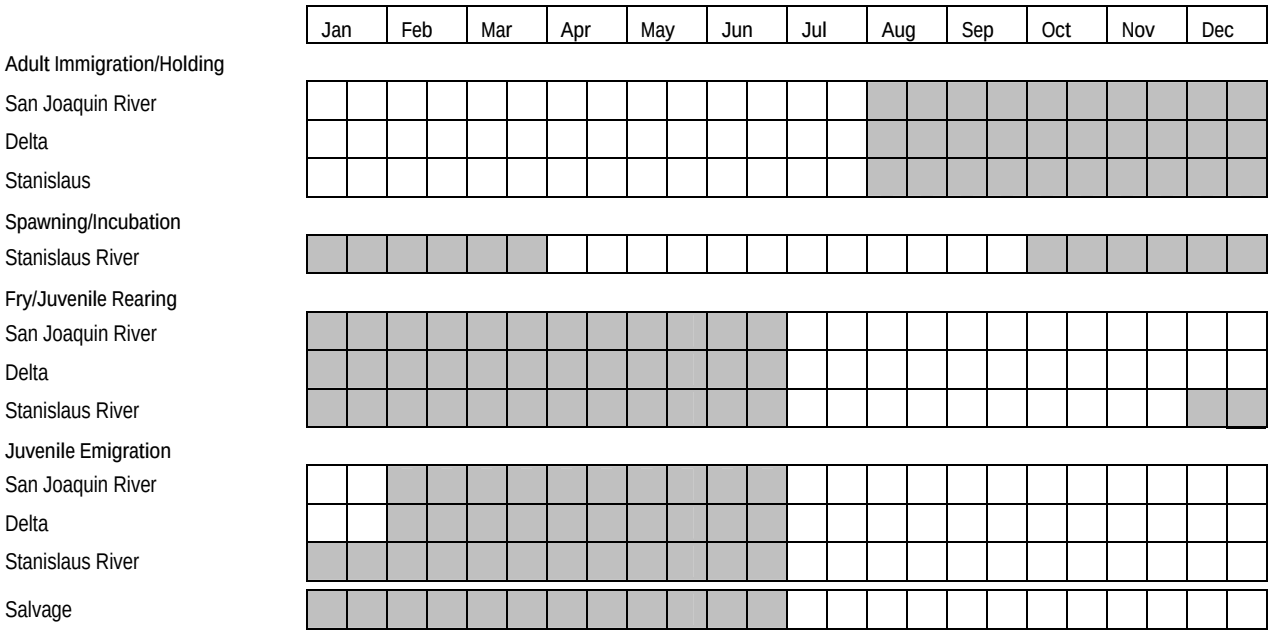
Chinook salmon populations of all runs have been impacted by the construction of dams and diversions on rivers and streams. Over 80 percent of their holding and spawning habitat is no longer accessible (Moyle 2002). Other threats include entrainment of juveniles in diversions, loss and degradation of floodplain and estuarine rearing habitat, exploitation, nonnative fish predators, nonnative fish and invertebrates causing ecological alterations, competition with hatchery-reared salmon, disease, pollution, siltation (e.g., from mining, logging, grazing), loss of riparian woodland that provides shade and large woody debris, and natural factors such as drought.

Fall-Run Chinook Salmon – Species of Concern

The Central Valley fall-run Chinook salmon ESU was classified as a Species of Concern on April 15, 2004 (NMFS 2004a, 69 FR 19975). The ESU includes all naturally spawned populations of fall- and late-fall-run Chinook salmon in the Sacramento River and SJR basins and their tributaries east of Carquinez Strait, California (NMFS 1999, 64 FR 50394).[3]

The fall run is the largest run of Chinook salmon. The fall run supports significant commercial and recreational fisheries along the Pacific Coast and in the area of analysis.

Fall-run Chinook salmon are already sexually maturing as they enter the freshwater environment and are typically ready to spawn within days once they reach their spawning areas. Adult Chinook salmon annually migrate upstream through the Delta from August through December (**Figure H1-5**). The spawning peak occurs upstream of the Delta from October through March, depending on the spawning location (Taylor and Wise 2008). More than 90 percent of the entire run has entered all the rivers by the end of November and migration and spawning can continue into December. Fall-run Chinook salmon migrate downstream through the Delta between February and June (Taylor and Wise 2008). The Delta is considered to be the major rearing area for fall-run juveniles from the fry to smolt life stages.



Source: Taylor and Wise 2008

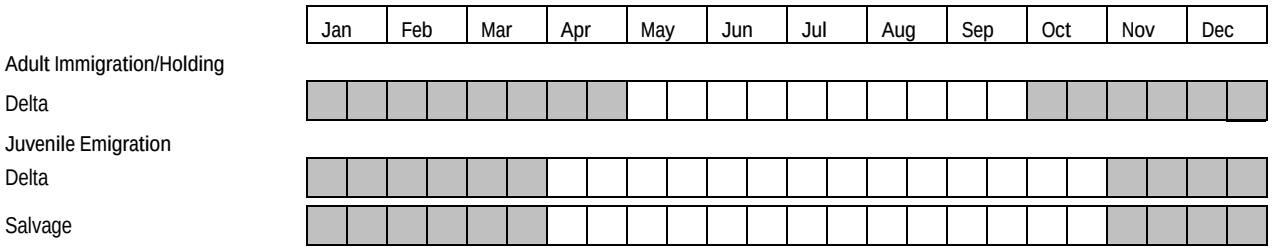
Figure H1-5. Timing of Life History States for Fall-Run Chinook Salmon

Late-Fall-Run Chinook Salmon – Species of Concern

The Central Valley late fall-run Chinook salmon ESU was classified as a Species of Concern on April 15, 2004 (NMFS 2004a, 69 FR 19975). The ESU includes all naturally spawned populations of fall- and late-fall-run Chinook salmon in the Sacramento River and SJR basins and their tributaries east of Carquinez Strait, California (NMFS 1999, 64 FR 50394).

Late fall-run Chinook salmon would occur in the Delta during migration to and from spawning and rearing habitat in the Sacramento River and its tributaries. They are not believed to use the SJR or its tributaries.

Adult immigration of late-fall-run Chinook salmon through the Delta generally begins in October, peaks in December, and ends in April (Moyle 2002) during a period of typically high, fluctuating flows (**Figure H1-6**). Spawning occurs upstream of the Delta from January to March, although it may extend into April in dry years. Late-fall-run juveniles emigrate from their spawning and rearing areas to the Delta from October through March (Taylor and Wise 2008). The majority of emigrating juveniles are smolt-sized by the time they reach the lower Sacramento River and Delta, typically from November through January. Occurrence of late-fall-run juveniles in the lower river appears to coincide with the first storms. However, the later the first storm occurs, the fewer late-fall-run juveniles that successfully migrate to the Delta (Snider and Titus 2000a, b). Some rearing may occur in the Delta during emigration.



Source: Taylor and Wise 2008

Figure H1-6. Timing of Life History Stages for Late-Fall-Run Chinook Salmon

Winter-Run Chinook Salmon – Endangered

Winter-run Chinook salmon were listed as endangered on January 4, 1994 (NMFS 1994, 59 FR 440). This status was reaffirmed on June 28, 2005 (NMFS 2005a, 70 FR 37160). The ESU includes all naturally spawned populations of winter-run Chinook salmon in the Sacramento River and its tributaries in California. Critical habitat for winter-run Chinook salmon was established effective July 16, 1993 (NMFS 1993, 58 FR 33212). The critical habitat designation includes the Sacramento River from Keswick Dam to Chipps Island, and all waters between Chipps Island and the Golden Gate Bridge and to the north of the San Francisco/Oakland Bay Bridge.

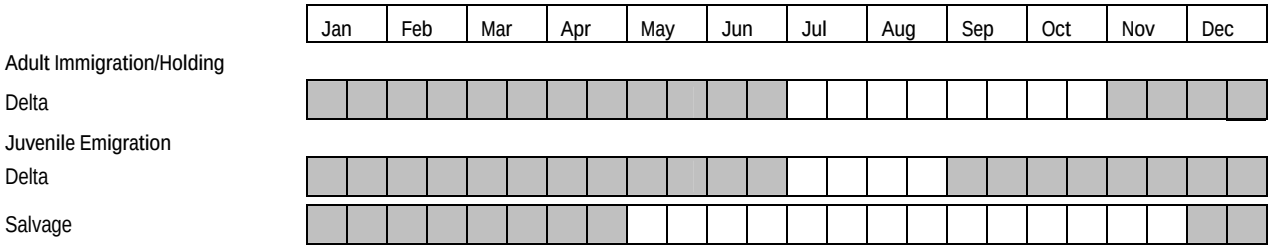
Winter-run Chinook salmon are unique to the Sacramento River system. Winter-run Chinook salmon do not use the SJR or its tributaries. These fish occur in the Delta during migration to and from spawning and rearing habitat in the Sacramento River and its tributaries.

Adult winter-run Chinook salmon immigration occurs from November through June (Taylor and Wise 2008) with a peak during the period extending from January through April (USFWS 1995) (**Figure H1-7**). Winter-run Chinook salmon primarily spawn in the mainstem Sacramento River above Red Bluff Diversion Dam from late-April to September, with the peak generally occurring from late June to early July.

Most winter-run Chinook salmon fry only rear for a short period in the upper Sacramento River above Red Bluff Diversion Dam. They use the Sacramento River from about Red Bluff to the Delta for rearing and emigration and may be present in this area from September through June (Taylor and Wise 2008). Winter-run Chinook salmon fry may rear for some time in the Delta as well.

The primary threat to winter-run Chinook salmon is the loss and degradation of spawning habitat. Winter-run Chinook salmon are further threatened by having only one small, extant population dependent on artificially created environmental conditions. These fish are further subject to inadequately

screened water diversions, predation at artificial structures, nonnative species, pollution, adverse flow conditions, high summer water temperatures, unsustainable harvest rates, passage problems at various structures, and vulnerability to drought (Good et al. 2005).



Sources: Taylor and Wise 2008

Figure H1-7. Timing of Life History Stages for Winter-Run Chinook Salmon

Spring-Run Chinook Salmon – Threatened

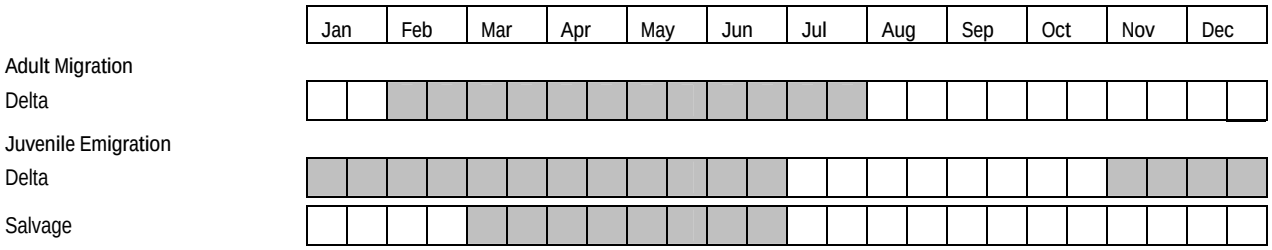
On June 28, 2005, NMFS issued its final decision to retain the status of Central Valley spring-run Chinook salmon as threatened (NMFS 2005a, 70 FR 37160). Designated critical habitat for the Central Valley spring-run Chinook salmon ESU includes 1,158 miles of stream habitat in the Sacramento River basin and 254 square miles of estuary habitat in the San Francisco-San Pablo-Suisun Bay complex (NMFS 2005b, 70 FR 52488).

Spring-run Chinook salmon are not believed to use the SJR or its tributaries. These fish occur in the Delta during migration to and from spawning and rearing habitat in the Sacramento River and its tributaries.

Historically, the SJR supported a large run of spring-run fish. This run was extirpated by development throughout the watershed. A few spring-run Chinook have been observed in the SJR tributaries (Moyle 2002). These fish are believed to be strays from the Sacramento River Basin. The initial phases of an effort to reestablish a spring-run on the SJR below Friant Dam are currently underway. The success of this effort remains to be seen.

Spring-run Chinook enter the Delta as sexually immature adults from February through July; peak migration is during April-May (Taylor and Wise 2008) (**Figure H1-8**). The adults typically mature in cool, deep pools in rivers upstream of the valley floor during the summer and spawn in suitable habitat adjacent to these areas from August through December, peaking in mid-September (Taylor and Wise 2008; Moyle 2002). Juvenile spring-run Chinook can rear for several months to over a year before emigrating. Most spring-run juveniles emigrate as smolts, although some portion of an annual year-class may emigrate as fry. Emigration timing varies among the tributaries of origin, and

can occur during the period extending from November through June (NMFS 2004b; Taylor and Wise 2008).



Source: Taylor and Wise 2008

Figure H1-8. Timing of Life History Stages for Spring-Run Chinook Salmon

The major threats to spring-run Chinook salmon include loss of historical spawning habitat, and the degradation and modification of rearing and migration habitats: reduced instream flow during spring-run migration periods, unscreened or inadequately screened water diversions, predation by nonnative species, and high water temperatures (Good et al. 2005).

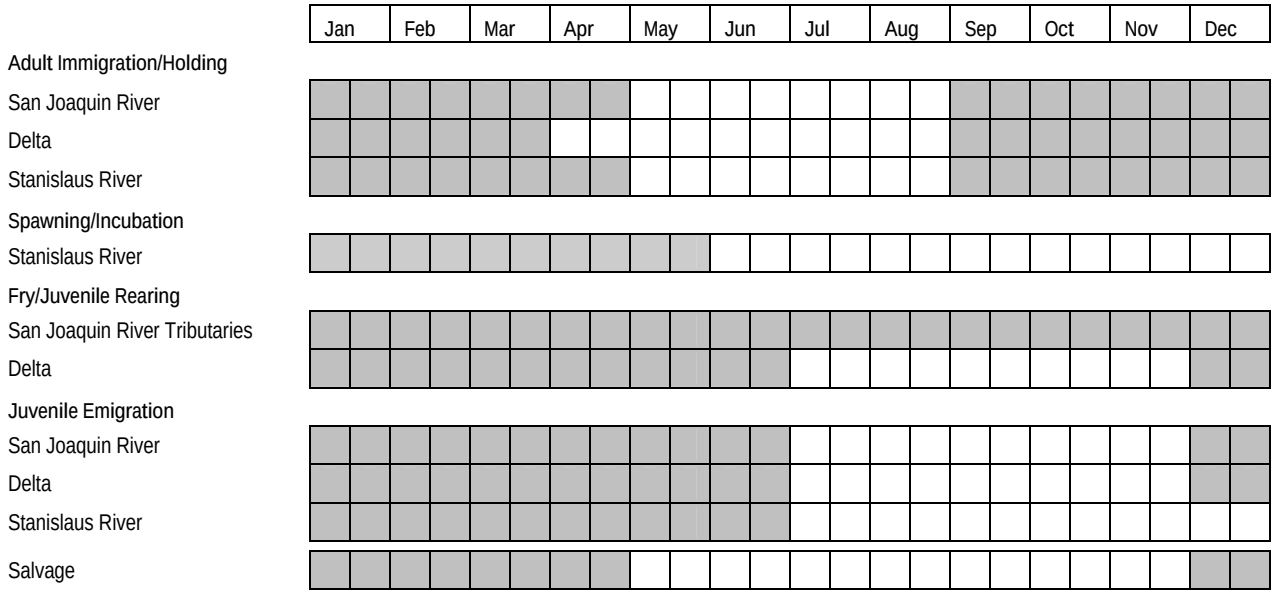
Steelhead – Threatened

The Central Valley steelhead ESU was listed as threatened on March 19, 1998, including all naturally spawned populations of steelhead in the Sacramento River and SJR and their tributaries, including the Sacramento-San Joaquin Delta (NMFS 1998, 63 FR 13347). Steelhead from San Francisco and San Pablo bays and their tributaries are excluded from this listing. On June 28, 2005, NMFS issued its final decision to retain the status of Central Valley steelhead as threatened (NMFS 2005a, 70 FR 37160). In 2006, the listing was reaffirmed but the ESU was redesignated as a distinct population segment (DPS). Critical habitat was designated for the Central Valley steelhead DPS on September 2, 2005 (NMFS 2005b, 70 FR 52488). Central Valley steelhead were well-distributed historically throughout the Sacramento River and SJR (Busby et al. 1996).

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries. Until recently, Central Valley steelhead were thought to be extirpated from the SJR system. However, recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus River and other streams previously thought to be devoid of steelhead (McEwan 2001). Incidental catches and observations of steelhead juveniles also have occurred on the Tuolumne and Merced rivers, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good et al. 2005).

The entire population of the Central Valley steelhead DPS must pass through the Delta as adults migrating upstream and juveniles emigrating out to the ocean. Juvenile steelhead likely use the Delta for rearing. Adult Central Valley steelhead migrating into the SJR and its tributaries use the western edge of the Delta, whereas adults of these species entering the Sacramento River system to spawn use the northern and central Delta for a migration pathway.

Adult steelhead immigrate from September to March (**Figure H1-9**); peak migration typically occurs in January and February (Moyle 2002). Adult immigration in the SJR generally occurs until April. Steelhead generally spawn January through May. No spawning occurs in the Delta or the SJR, but it does occur in the Merced, Tuolumne, and Stanislaus rivers.



Source: Taylor and Wise 2008

Figure H1-9. Timing of Life History Stages for Steelhead

Steelhead juveniles rear in Central Valley streams for 1 to 2 years. Optimal temperatures for fry and juvenile rearing are reported to range from 55°F to 65°F (NMFS 2004b), although steelhead have been observed to grow to smolt size where summer-fall temperatures exceed 65°F (Titus, pers. comm., 2005). Steelhead can begin emigrating in the late fall, but the primary period of steelhead emigration occurs from December through May (Snider and Titus 2000a, b; NMFS 2004b). When emigrating, Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Some may use tidal marsh areas, nontidal freshwater marshes, and other shallow water areas in the Delta as rearing areas.

Steelhead populations have been most significantly impacted by the construction of dams that block access to headwaters of the mainstem Sacramento River and SJR and all their major tributaries (McEwan and Jackson 1996). Other threats include low and inadequate river flows due to excessive diversions, elevated water temperatures, unscreened or poorly screened diversions, and predation by exotic species.

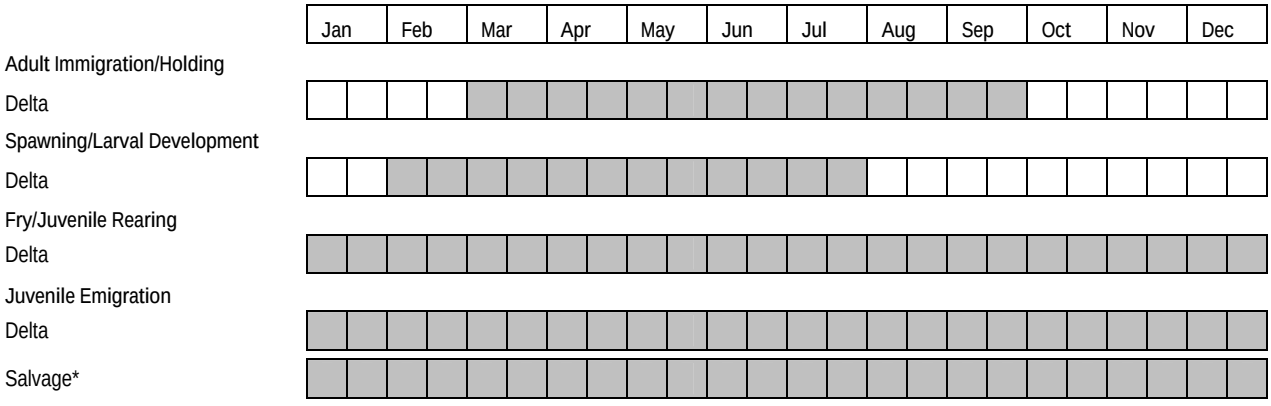
H1.1.6 Sturgeon

Green Sturgeon – Threatened

On June 6, 2006, the Southern DPS (consisting of coastal and Central Valley populations south of Eel River) of green sturgeon were listed as threatened (NMFS 2006, 71 FR 17757). Critical habitat has not yet been designated for this DPS.

The green sturgeon is an anadromous, native fish that occurs in low numbers in the Bay/Delta system (Moyle 2002). Adults tend to be more marine-oriented than the more common white sturgeon. In freshwater, green sturgeon use the Sacramento River and its major tributaries, but migrate through and may forage and rear in the Delta. They are not believed to use the SJR or its tributaries (NMFS 2006, 71 FR 17757).

Adults begin their upstream migration in March (Taylor and Wise 2008), and enter the Sacramento River until the end of September (Taylor and Wise 2008) (**Figure H1-10**). Spawning occurs upstream of the Delta from February through July, with peak activity believed to occur from April to June (Taylor and Wise 2008; Moyle et al. 1995). Green sturgeon spawning occurs predominately in the upper Sacramento River (NMFS 2002). Juvenile green sturgeon spend 1 to 3 years in freshwater prior to emigrating to the ocean (NMFS 2005c).



Source: Taylor and Wise 2008
*Salvage periodicity for sturgeon is not a useful criterion for analysis due to very low numbers.

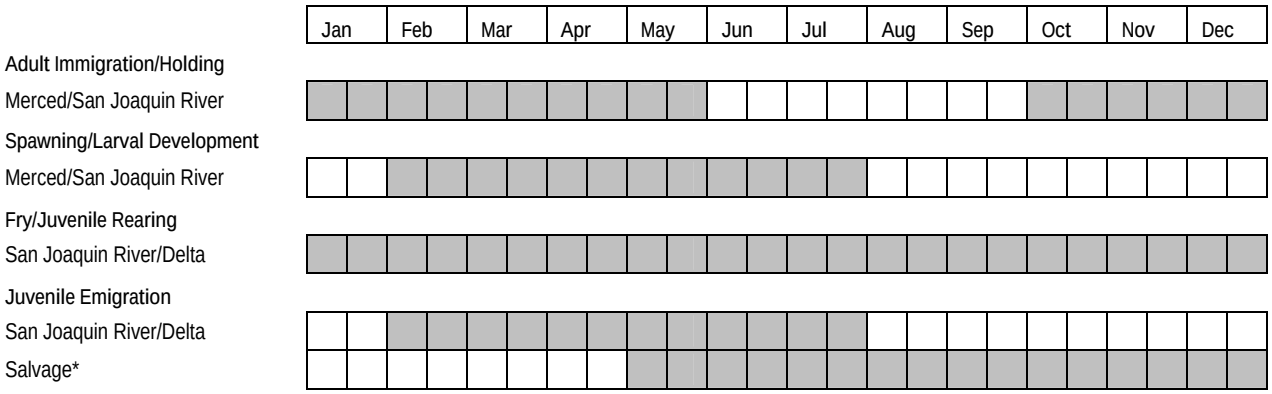
Figure H1-10. Timing of Life History Stages for Green Sturgeon

Green sturgeon population threats include vulnerability due to concentration of spawning habitat, smaller population size, lack of population data, potentially growth-limiting and lethal temperature tolerances, harvest concerns, loss of spawning habitat, entrainment by water projects, and influence of toxic material and exotic species (NMFS 2002).

White Sturgeon – No Legal Status

White sturgeon occur in the Delta and its tributary rivers, including both the Sacramento River and SJR and their larger tributaries. Some individuals may also migrate out into the Pacific Ocean. Most California white sturgeon are found in the San Francisco Bay estuary. This species is not listed under Federal or California ESAs, although its populations have declined over historic levels.

Migration of mature adult white sturgeon begins in October and continues into May (**Figure H1-11**). Most spawning occurs in the Sacramento River from February through July, peaking in March and April (Kohlhorst 1976). About 10 percent of the adult population (Kohlhorst and Cech 2001) migrates into the SJR, from Mossdale to the mouth of the Merced River (October through May). Spawning migration may begin several months before the spawning period (Kohlhorst 1976; Moyle 2002). Spawning and larval development occur in the SJR and Merced River between February and July (Taylor and Wise 2008).



Source: Taylor and Wise 2008
*Salvage periodicity for sturgeon is not a useful criterion for analysis due to very low numbers

Figure H1-11. Timing of Life History Stages for White Sturgeon

White sturgeon typically complete their life cycle within the Delta and its major tributaries, the Sacramento River and SJR. Few fish enter the ocean, but some that do so make coastal migrations extending at least as far as the Columbia River Basin (Moyle 2002). During most of the year, adults are concentrated in San Pablo and Suisun bays, where they feed principally on bottom-dwelling invertebrates.

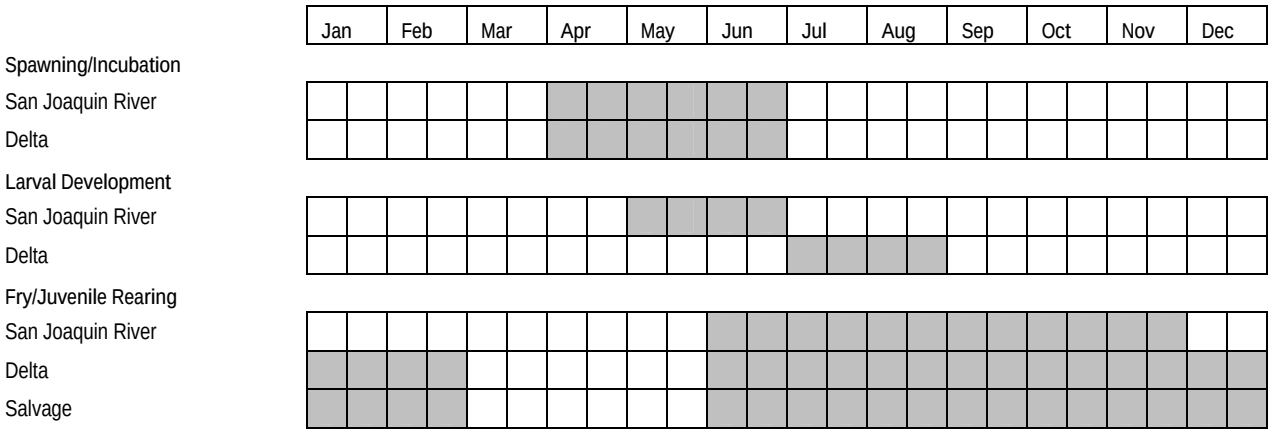
H1.1.7 Other Species of Concern

American Shad – No Legal Status

American shad are an introduced, anadromous species that supports recreational fisheries in the Delta and Central Valley rivers. This species is not listed under the Federal or California ESA, nor are they a species of concern beyond their recreational importance.

American shad occur in the Sacramento River, its major tributaries, the SJR, and the Delta.

Adult American shad are abundant in the Delta in spring during their upstream migration between April through June (CDFG 1986) (**Figure H1-12**). Many shad spawn in the rivers tributary to the Sacramento River above the Delta. Water temperature strongly influences the timing of spawning. Juvenile shad are found north of the Delta on the Sacramento River and to a lesser extent in the south Delta (Moyle 2002). This life stage is extremely vulnerable to entrainment in agricultural diversions in the Delta, power plant cooling water diversions, and pumps in the South Delta (Moyle 2002). They migrate downstream to reach the ocean in fall, but sometimes migrate as early as late June when outflows are high.



Source: Taylor and Wise 2008

Figure H1-12. Timing of Life History Stages for American Shad

American shad population declines in recent years are likely caused by the increased diversion of water from the rivers and the Delta, combined with changing conditions in the ocean. Pesticides and other factors may also be contributing to their decline (Moyle 2002).

Splittail – California Species of Concern

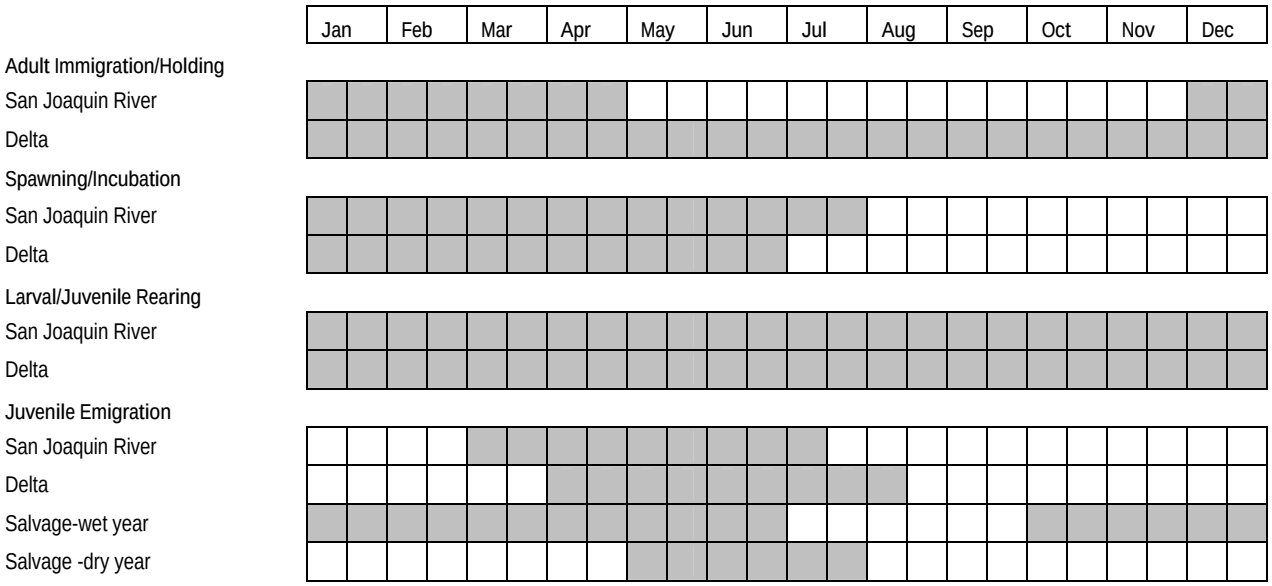
The Sacramento splittail was federally listed as threatened on February 8, 1999 (USFWS 1999, 64 FR 5963), and delisted on September 22, 2003 (USFWS 2003, 68 FR 55139). The splittail is listed as a species of special concern under the California ESA (Moyle et al. 1995).

Splittail, a euryhaline nongame fish, are largely confined to the Delta, Suisun Bay, Suisun Marsh, Napa River, Petaluma River, and other parts of the San Francisco estuary (Moyle 2002). In the Delta, they are most abundant in the northern and western portions when populations are low.

Splittail can exist within a wide range of habitat conditions (Moyle et al. 2004). Conditions important to maintaining viable splittail populations include availability of floodplains for successful spawning, with migration corridors from spawning to rearing grounds, and abundant high-quality brackish water rearing habitat (Moyle et al 2004).

The timing of splittail upstream movements and spawning corresponds to the historical spring, high-flow period. Timing and location of spawning varies among years depending on the timing and magnitude of winter and spring runoff. Adult splittail migrate upstream to freshwater areas to spawn between December and April (Taylor and Wise 2008; **Figure H1-13**). Spawning occurs in seasonally inundated floodplains in January through June, or even through July in the SJR at water temperatures from 57°F to 66°F (Moyle 2002; DWR and Reclamation 2005). Splittail prefer to spawn over flooded vegetation or beds of aquatic plants. Larval splittail are commonly found in shallow, vegetated areas near spawning habitat. Larvae eventually move into deeper and more open-water habitat as they grow and become juveniles (DWR and Reclamation 2005). Developing juveniles migrate downstream to shallow, brackish-water year-round rearing grounds from March through August.

Sacramento splittail populations have been reduced due to loss and modification of riverine spawning and rearing habitat and changes in hydrology. Flood control processes have created artificial hydrologic conditions that may reduce the regularity of flooding in floodplain habitat, such as the Cosumnes floodplain and Yolo Bypass. Juvenile splittail are thought to begin migrating downstream with increasing water temperatures; however, artificially constructed channels in the watershed are often too deep to sufficiently warm the water. Other threats to the population include variations in climate, introduction of nonnative predators and competitors, toxic substances, and angler harvest (Moyle 2002).



Source: Taylor and Wise 2008

Figure H1-13. Timing of Life History Stages for Sacramento Splittail

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